

# ATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

**PCT**

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C.20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing:

15 June 2000 (15.06.00)

International application No.:

PCT/US99/28230

Applicant's or agent's file reference:

18062R-9161P

International filing date:

29 November 1999 (29.11.99)

Priority date:

04 December 1998 (04.12.98)

Applicant:

KING, Ya-Chin et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International preliminary Examining Authority on:

13 April 2000 (13.04.00)



in a notice effecting later election filed with the International Bureau on:

2. The election



was



was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

## PCT

REC'D 25 JAN 2001

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT


(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 15057-9161P	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US99/28230	International filing date (day/month/year) 29 NOVEMBER 1999	Priority date (day/month/year) 04 DECEMBER 1998
International Patent Classification (IPC) or national classification and IPC IPC(7): C23C 14/16; H01L 21/31, 21/469, 23/58 and US Cl.: 427/527; 438/766, 770; 257/638		
Applicant THE REGENTS OF THE UNIVERSITY OF CALIFORNIA		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  13 APRIL 2000	Date of completion of this report  20 NOVEMBER 2000
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer  M.L. PADGETT Telephone No. (703) 308-0651

Form PCT/IPEA/409 (cover sheet) (July 1998) \*

Copied from 0988/453 on 01-12-2003

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US99/28230

**I. Basis of the report**1. With regard to the **elements** of the international application:\*☒ the international application as originally filed☒ the description:

pages 1-6 , as originally filed  
pages NONE , filed with the demand  
pages NONE , filed with the letter of \_\_\_\_\_

☒ the claims:

pages 7-9 , as originally filed  
pages NONE , as amended (together with any statement) under Article 19  
pages NONE , filed with the demand  
pages NONE , filed with the letter of \_\_\_\_\_

☒ the drawings:

pages 1/6 - 6/6 , as originally filed  
pages NONE , filed with the demand  
pages NONE , filed with the letter of \_\_\_\_\_

☒ the sequence listing part of the description:

pages NONE , as originally filed  
pages NONE , filed with the demand  
pages NONE , filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☐ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:☐ contained in the international application in printed form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.4. ☒ The amendments have resulted in the cancellation of:☒ the description, pages None☒ the claims, Nos. None☒ the drawings, sheets/fig None5. ☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\*Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US99/28230

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. statement**

Novelty (N)	Claims <u>1-15 and 17-19</u>	YES
	Claims <u>16 and 20</u>	NO
Inventive Step (IS)	Claims <u>None</u>	YES
	Claims <u>1-20</u>	NO
Industrial Applicability (IA)	Claims <u>1-20</u>	YES
	Claims <u>None</u>	NO

**2. citations and explanations (Rule 70.7)**

Claims 1-20 meet the criteria set out in PCT Article 33(4), as can be seen by reading the title of the application.

Claims 16 and 20 lack novelty under PCT Article 33(2) as being anticipated by Aklafi or Hayashi.

Claims 5-6, 13-15 and 17-20 lack an inventive step under PCT Article 33(3) as being obvious over Aklufi in view of Nakai et al.

Aklufi teaches creating buried gate insulator layers by implanting elements, such as oxygen, into a structure at 400°C, with sufficient energy and dose to form an oxide layer in the semiconductor layer. Semiconducting layer 10 is on top of insulating layer 16, with SiO<sub>2</sub> (18) and Si<sub>3</sub>N<sub>4</sub> (20) layers formed on layer 10, then patterned and used as a mask, for implanting an element such as oxygen at 400 °C in order to form an insulating layer with thicker regions where exposed to the oxygen implanting via the mask. Thermal annealing is preforming to complete insulator formations, and the masking layers 18 and 20 are removed. While Aklufi teach semiconductor layers in their process, they do not specifically specify that it may be a polysilicon layer, however Nakai et al demonstrate that buried layers of silicon oxide may be formed by oxygen ion implanting as practiced in Aklufi, when the semiconductor material above the formed oxide in polysilicon, hence it would have been obvious to one of ordinary skill in the art to alternatively use polysilicon as the semiconductor in Aklufi as it has been shown to be effective in the taught process and is known for use in like devices, so would have been expected to be effectively treated.

While particular thicknesses of oxide gate layers are not taught, they would have been determined by intended end use plus routine experimentation for desired circuit properties for those end uses.

Claims 1-4 and 7-12 lack an inventive step under PCT Article 33(3) as being obvious over Joyner et al in view of Thakur et al.

(Continued on Supplemental Sheet.)

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 1-20 objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because the claims 1-20 indefinite for the following reason(s):

In claim 1, both the "sacrificial oxide layer" and the "implant mask layer" are required to be "on the silicon substrate" (emphasis added). However limitation (C) appears to indicate that the sacrificial oxide layer is between the mask and the substrate, which is inconsistent with the requirements of 1(b). Note that unless there are temporal, or antecedent basis limitations to define order of doing steps, merely listing steps in some order does NOT provide any necessary meaning to a (process) claim. In 1(f) there is no clear relationship between the "oxide layer" and its ... regions, which are grown on the silicon substrate, and the oxygen implanting done in 1(c), especially since the implantation was into the substrate, hence does not appear to include any part of the grown oxide layer.

As the independent claims do not use the nomenclature of "step(s)", reference to step (c), and the like in dependent claims (3, 4, 6 and 9) have no clear or necessary meanings, due to inconsistent wording.

The mixed use of end point limiters, such as "less than" and "about" creates contradictory limiting values, because the former only includes values below the given value, but "about" also includes larger values, making the metes and bounds vague and indefinite.

Claim 5, has logic problems analogous to those of claim 1(f), in that there is no necessary relationship to the ion implanting that takes place in 5(d), and the oxygen-implanted oxide of 5(f). Also note that 5(d) never says where the O is implanted, only what it goes through.

Claim 7, has logic problems analogous to 1(a) and (b), with two layers on the substrate, while in its last line (in 7(f)) "the oxygen-implanted region" lacks proper antecedent basis as it is newly introduced terminology, but at least "the selected first portion" clearly refers back to 7(d).

In claim 9, line 1 due to the lack of an article showing antecedent basis it is unclear if "implanting oxygen..." refers to the same action as claimed in 7(c) or if it is an additional one. Also, in lines 2-3 "the oxygen concentration" is used twice, first without proper antecedent basis, and the second occurrence also if it is intended to be differentiated, which is not clear from the words used, but appears logical from the context.

In claim 12 "oxygen" in line 2 lacks a correct article to show its antecedent basis.

In claim 13, use of relative terms, such as "high", which lack clear metes and bounds, is vague and indefinite unless a definition therefore is provided in the case, or the original (Continued on Supplemental Sheet.)

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 10

**V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):**

Joyner et al teaches use of a sacrificial layer that may be Si oxide for use when oxygen ion implanting a semiconductor wafer that may be silicon, in order to form a buried oxide layer. Joyner et al does not use a mask, however use of masks for patterning is old and well known, and as shown by Thakur et al used for patterned formation of buried oxide layers as produced in Joyner et al., hence it would have been obvious to use a mask on top of the sacrificial layer of Joyner et al in order to form buried oxide layer with specific patterns for particular end uses. The thicknesses and ion doses would have been determined according to particular needs of specific end uses.

----- NEW CITATIONS -----  
NONE

**VIII. CERTAIN OBSERVATIONS ON THE APPLICATION (Continued):**

description, or form a relevant prior art publication. The preamble of claim 13 is not commensurate in scope with the steps, because neither the dielectric layer, nor the "interfacial oxide layer" are necessarily "multiple-thickness", ie. related to the layer recited in the preamble. Note claim 1 also has an analogous problems.

The claim 16 preamble requires a device, but the structure therein described is not commensurate in scope with the preamble as it consist of nothing but a gate oxide with two regions of different thickness. This is NOT a device, it is merely a layer with uneven thicknesses. Note while "being oxygen-implanted" is used to describe the second region, the only structure necessitated is that it is thicker than the first region.

Claims 19-20 are method limitations, that provide no clear structure to the product claims, as oxygen implanted and oxidized by other means are not necessarily different structures as claimed. Furthermore, in claim 20 "the first gate oxide" (line 1) has no antecedent basis due to inconsistent nomenclature, while "the implanted oxygen concentration" (either occurrence) appears to lack proper antecedent basis, as they are not inherent properties.



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06.03.03

Zeichen/Ref./Réf. URW.43205	Anmeldung Nr./Application No./Demande n°/Patent Nr./Patent No./Brevet n°. 99960614.8-2203-US9928230
Anmelder/Applicant/Demandeur/Patentinhaber/Proprietor/Titulaire THE REGENTS OF THE UNIVERSITY OF CALIFORNIA	

## COMMUNICATION

The European Patent Office herewith transmits as an enclosure the European search report for the above-mentioned European patent application.

If applicable, copies of the documents cited in the European search report are attached.

☒ Additional set(s) of copies of the documents cited in the European search report is (are) enclosed as well.

## REFUND OF THE SEARCH FEE

If applicable under Article 10 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.





European Patent  
Office

SUPPLEMENTARY  
EUROPEAN SEARCH REPORT

Application Number  
EP 99 96 0614

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 967 245 A (COGAN ADRIAN I ET AL) 30 October 1990 (1990-10-30)	16, 19	C23C14/16 H01L21/31
Y	* column 3, line 3-13; figure 3A *	1-4, 7-12, 17, 18, 20	H01L21/469 H01L23/58 H01L21/8234
Y	--- US 5 480 828 A (LIN MOU S ET AL) 2 January 1996 (1996-01-02)	1-4, 7-12, 17, 18, 20	
A	* column 3, line 1-30; figures 4, 5 * * column 3, line 31 - column 4, line 7; figures 6, 7 * -----	5, 6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01L
The supplementary search report has been based on the last set of claims valid and available at the start of the search.			
Place of search MUNICH		Date of completion of the search 25 February 2003	Examiner Boetticher, H
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

1  
EPO FORM 1503 03 82 (PstC04)



ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 99 96 0614

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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25-02-2003

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4967245	A	30-10-1990	NONE	
US 5480828	A	02-01-1996	NONE	



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : C23C 14/16, H01L 21/31, 21/469, 23/58	A1	(11) International Publication Number: WO 00/34548 (43) International Publication Date: 15 June 2000 (15.06.00)
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(21) International Application Number: PCT/US99/28230

(22) International Filing Date: 29 November 1999 (29.11.99)

## (30) Priority Data:

60/110,885	4 December 1998 (04.12.98)	US
09/449,063	24 November 1999 (24.11.99)	US

## (63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Applications

US	60/110,885 (CON)
Filed on	4 December 1998 (04.12.98)
US	09/449,063 (CON)
Filed on	24 November 1999 (24.11.99)

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(72) Inventors; and

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CA 94539 (US). HU, Chen, Ming [US/US]; 2060 Pebble Drive, Alamo, CA 94507 (US).

(74) Agents: WOODWARD, Henry, K. et al.; Townsend and Townsend and Crew LLP, 8th floor, Two Embarcadero Center, San Francisco, CA 94111-3834 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

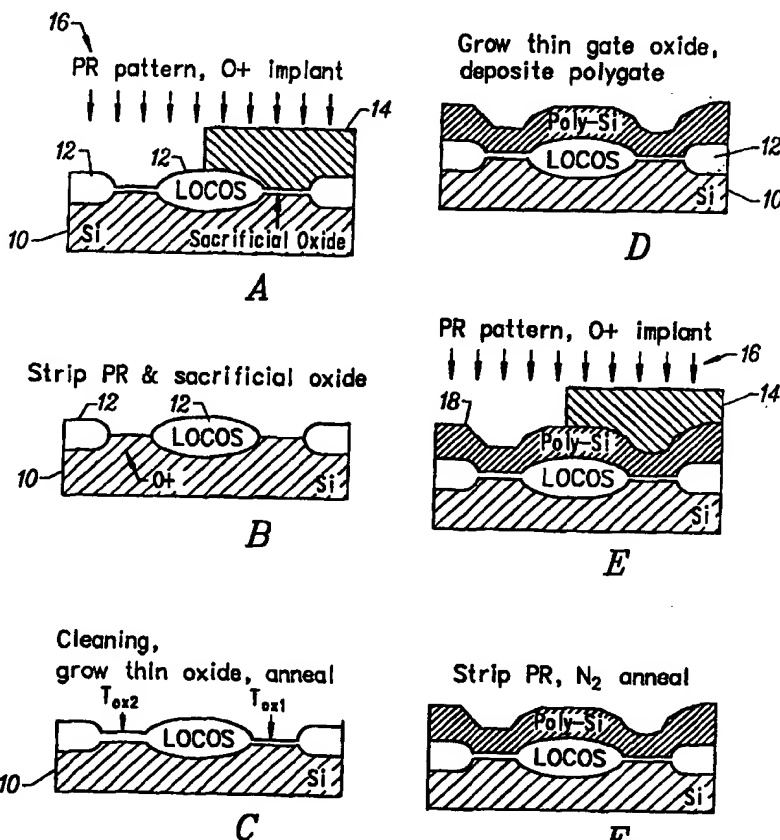
Published

With international search report.

(54) Title: MULTIPLE-THICKNESS GATE OXIDE FORMED BY OXYGEN IMPLANTATION

## (57) Abstract

A process for forming gate oxides of multiple thicknesses. In one embodiment (1A-C), oxygen (16) is implanted through a sacrificial oxide (12) into selected regions of a silicon substrate (10) according to a patterned photoresist mask (14). After stripping the sacrificial oxide, a thermal growth process produces a thicker oxide in the implanted regions ( $T_2$ ) than in the non-implanted regions ( $T_1$ ). The oxygen-implanted oxide has excellent quality and thickness differentials of up to 20 Å may be obtained with relatively low oxygen implant doses. In an alternative process (1D-E), a thin gate oxide layer deposition (18), and oxygen is then implanted through the polysilicon according to a patterned photoresist mask. After stripping the photoresist, an anneal increases the thickness of the gate oxide in the implanted regions. In another embodiment, a high dielectric constant dielectric layer is deposited on the substrate prior to polysilicon deposition to limit subsequent silicon oxide growth.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US99/28230

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : C23C 14/16; H01L 21/31, 21/469, 23/58

US CL : 427/527; 438/766, 770; 257/638

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 427/527; 529; 438/763, 766, 770, 787, 798, 920; 257/632, 635, 638, 647

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,105,805 A (GLEDINNING et al) 08 August 1978 (08/08/78), see abstract; col. 2, lines 15-42.	13-15
X --- Y	US 4,874,718 A (INOUE) 17 October 1989 (17/10/89), see abstract; Figures 1A-1H; Fig. 4; col. 4, line 14 - col. 5, line 68.	16, 20 ----- 5-6, 13-15, 17-19
X --- Y	US, 4,704,302 A (BRUEL et al) 03 November 1987 (03/11/87), see abstract; Figures.	16 ----- 5-6, 13-15, 17-20

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A* document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*B* earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

14 JANUARY 2000

Date of mailing of the international search report

16 FEB 2000

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## INTERNATIONAL SEARCH REPORT

 International application No.  
 PCT/US99/28230

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,968,636 A (SUGAWARA) 06 November 1990 (06/11/90), see abstract; Fig. 2a-b, 3a-b, 6a-b; col. 7, lines 5-3; col. 9, lines 39-49; col. 10, lines 18-57.	1-4, 7-12
Y	US 5,077,225 A (LEE) 31 December 1991 (31/12/91), see abstract; Fig. 1-6; Col. 3, lines 13 - col. 4, line 40; and claim 1.	13-20
X	US 5,182,226 A (JANG) 26 January 1993 (26/01/93), see abstract; Fig. 2a-e; Col. 1, lines 7-14; Col. 2, lines 25 - col. 3, line 8.	16
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Y		17-20
Y	US 5,183,775 A (LEVY) 02 February 1993 (02/02/93), see abstract; Figures 1-5; col. 1, lines 9-15; Col. 3, lines 1-68; col. 5, line 23 - col. 6, line 18.	1-4, 7-12
Y	US 5,364,900 A (JOYNER) 15 November 1994 (15/11/94), see Abstract; Figures; Col. 4, line 22- Col. 5, line 47.	1-15
Y	US 5,429,955 A (JOYNER et al) 04 July 1995 (04/07/95), see abstract; figures; col. 3, lines 1-60.	1-15
Y	US 5,441,899 A (NAKAI et al) 15 August 1995 (15/08/95), see abstract; Figures 1A-D; Col. 5, lines 50 - Col. 6, line 52.	5-6, 13-15
X	US 5,616,509 A (HAYASHI) 01 April 1997 (01/04/97), see abstract; Figures 9A - 11D; Col. 4, lines 34 - 60 and Col. 5, lines 45 - col. 6, line 20.	16, 20
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Y		5-6, 13-15, 17-19
Y	US 5,658,809 A (NAKASHIMA et al) 19 August 1997 (19/08/97), see abstract; Figure 1-6 and 9-11; Col. 2, lines 40-60; col. 3, lines - Col. 6, line 40.	1-15
X	US 5,705,412 A (AKLUFU) 06 January 1998 (06/01/98), see abstract, Figures 1B-1F and Col. 2, line 58 - Col. 3, line 35.	5, 13-14
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Y		6, 15, 17-20
Y	US 5,712,186 A (THAKUR et al) 27 January 1998 (27/01/98), see Abstract, Figure 2-3; Summary; Col. 4, lines 13-68.	1-4, 13-15
A	US 5,780,347 A (KAPOOR) 14 July 1998 (14/07/98), see abstract, Figure 4, claims.	5-6, 13-15

Form PCT/ISA/210 (continuation of second sheet)(July 1992)\*